Earth Science Education Products & Resources

NASA's Earth Science Education Product Review is a critical part of ESE's education program. This independent review includes panels of educators and scientists, who assess education materials based on their scientific accuracy and educational value. The review includes Earth system science education products developed by NASA, as well as materials developed by other agencies and organizations. Education products listed in this section have been reviewed and approved by NASA.

Beginning in 2001,ESE adopted a Seal of Approval for Earth Science education materials. NASA awards this distinction to education products that have passed its peer review. Products are due spring and fall for the review. For more information,see: http://earth.nasa.gov/education/esereview/index.html

Most of these materials listed here are available over the Internet. Many are also available at NASA Educator Resource Centers http://spacelink.nasa.gov/erc or for purchase from NASA's Central Operation of Resources for Educators http://core.nasa.gov, which distributes materials to teachers, nationally and internationally, for a shipping and handling charge.

Formal Education
- Elementary
- Middle School
- High School
- Postsecondary

Informal Education

Educational Resources
- Bookmarks
- Brochures
- NASA Earth Science Enterprise Science Writing and Multimedia Team
- Lithographs
- NASA Earth Science Missions—Education
- NASA Facts
- Newsletter
- Posters
- Videotapes
- Web Sites

FORMAL EDUCATION

CLASSROOM/CURRICULUM MATERIALS

ELEMENTARY

The Adventure of Echo the Bat Pop-Up Book

http://imagers.gsfc.nasa.gov/k-4/index.html

This picture book of Echo the Bat is accompanied by a set of activities that reinforce four basic themes or concepts fundamental to the interpretation of satellite imagery: perspective, shape and pattern, color, and texture. Activities and activity sheets are also provided on a companion Web site: http://imagers.gsfc.nasa.gov/k-4/index.html. *Recommended for:* K–4.

Earth & Sky

http://earthsky.com

Earth & Sky (E&S) and NASA's Earth Science Enterprise have collaborated on a series of 90-second radio programs highlighting ESE science, with scientists participating from Goddard Space Flight Center and Jet Propulsion Laboratory. The E&S radio series programs are produced for a measured audience of more than 3.8 million listeners (weekly). The E&S Web site contains links to the audio and text files for all E&S shows, as well as links to related educational resources. *Recommended for:* K–12 and informal education.

Earth Update

http://earth.rice.edu/connected/earthupdate.html
http://core.nasa.gov

Rice Space Institute developed this CD-ROM, which contains Earth science information, movies, and classroom activities. The CD is suitable as a stand-alone museum kiosk or for use in a school classroom or library. If the user's computer is connected to the Internet, today's data can be downloaded with a single click. Each "sphere" (Atmosphere, Biosphere,

Cryosphere, Geosphere, and Hydrosphere) can be run separately or as the linked Earth Update. Each sphere includes sections: What (What is the atmosphere), Who (Who studies the biosphere), Why (Why do we study the cryosphere?), and How (How do we study the geosphere?). Classroom activities aligned with national science, math, and geography standards are included on the CD. Also available from NASA CORE. *Recommended for:* K–12 and informal education.

Everyday Classroom Tools

http://hea-www.harvard.edu/ECT

The major theme explored in this curriculum is the pattern of change on planet Earth as it relates to the sun. So many different subjects can be usefully mapped to this set of investigations of the world around us that it gives educators an opportunity to build upon an inquiry framework with their own related and connected ideas from different disciplines. *Recommended for:* Grades K–6.

Exploring Earth from Space: Lithograph Set and Instructional Materials, LS-1999-05-001-HQ

http://spacelink.nasa.gov/products/Exploring.Earth.From.Space

Shuttle astronauts and the EarthKAM program provide photos of our planet from the unique perspective of Earth orbit. This resource can enhance students' studies of Earth and space science, geography, social studies, mathematics, and educational technologies. The set contains an educators' guide, student information and worksheets, and several Earth photos taken from the Space Shuttle. *Recommended for:* Grades 3–12.

Exploring the Environment

http://www.cotf.edu/ete

Online, problem-based modules developed by NASA's Classroom of the Future for K–4,5–8, and 9–12 teachers and students. Modules address events such as volcanoes, hurricanes, dinosaur extinction theories, deforestation, endangered species, and global change. *Recommended for:* K–12.

From a Distance: An Introduction to Remote Sensing/GIS/GPS

http://education.ssc.nasa.gov/ltp

This Web site was developed and is maintained by NASA John C. Stennis Space Center. It includes lesson plans on remote sensing for grades K–3, 4–8, and 9–12 and links to related education resources. *Recommended for:* K–12.

Glacier Power

http://www.asf.alaska.edu:2222
http://core.nasa.gov

This 1997 CD-ROM is a curriculum supplement module on the topic of glaciers that was developed in cooperation with NASA by the Alaska Synthetic Aperture Radar Facility (ASF) at the University of Alaska, Fairbanks and in cooperation with the Fairbanks North Star Borough School District and the University of Alaska Fairbanks, School of Education.

The guide includes information on glaciers and their importance to climate studies; lesson plans; student review exercises, activities, and projects; and resources such as glacier imagery, satellite imagery, illustrations, diagrams, and more. Available online at (see Web site above) or on CD-ROM from NASA CORE. *Recommended for:* Grades 3–5.

GLOBE Program

http://globe.fsl.noaa.gov

Students from all over the world are participating in the Global Learning and Observations to Benefit the Environment (GLOBE) program by taking daily environmental measurements at their schools and sharing their data via the Internet. Some features on this Web site are specially designed and available only to GLOBE teachers and students who are trained in GLOBE measurement procedures. However, most features are available to anyone wanting to learn more about GLOBE, review the scientific areas of GLOBE study, read the GLOBE Teachers' Guide, and access student data. *Recommended for:* Elementary–high school.

Mission Geography

http://missiongeography.org

Mission Geography is curriculum support materials that link the content, skills, and perspectives of *Geography for Life: The National Geography Standards* with the missions, research, and science of NASA. Developed by the Geography Education National Implementation Project (GENIP) at Texas A&M University. *Recommended for:* K–12.

Our Mission to Planet Earth: A Guide to Teaching Earth System Science, 1994

http://spacelink.nasa.gov/products/Our.Mission.to.Planet.Earth

Provides hands-on activities and information related to studying the Earth system. Its primary goal is for children to become familiar with the concept of cycles and to learn that some human activities can cause changes in their environment. *Recommended for:* Grades K–3.

The Potential Consequences of Climate Variability and Change

http://www.strategies.org/CLASS.html

This set of inquiry-based, classroom-ready activities for grades 1–12 includes 12 modules. The modules provide a climate change overview activity, as well as examine the relationship of climate change to areas such as agriculture, coastal areas, forestry, human health, and water. They contain activities developed with the purpose of introducing students to current research about the potential impacts of climate variability and change. Each activity responds to national education standards in the English language arts, geography, social studies, mathematics, and science. *Recommended for:* Grades 1–12.

Students' Cloud Observations Online (S'COOL)

http://scool.larc.nasa.gov

S'COOL is a component of NASA's Clouds and the Earth's Radiant Energy System (CERES) project, which is providing global data on clouds. S'COOL participants make ground truth measurements for the CERES experiment, which are land-based observations to compare with satellite data for the purpose of improving the satellite results. The S'COOL Web site provides information on the project and how to participate, as well as classroom materials and resources. *Recommended for:* Grades 3–12.

teachearth.com

http://teachearth.com

Searchable Web site with links to classroom materials and resources for teaching and learning about Earth system science. Users can search by grade level and subject. Developed by the Institute for Global Environmental Strategies. *Recommended for:* K–12.

Understanding the Biosphere from the Top Down

http://geo.arc.nasa.gov/sge/jskiles/top-down/intro_product/title-page.html

This Web site contains a 22-lesson package written by eight local teachers working with the advice and help of NASA Ames Research Center personnel in Earth Sciences. The lessons focus on studying the biosphere from space to teach students about the Earth system. *Recommended for:* Grades 4–12.

Virtual Vacationland

http://www.bigelow.org/virtual

Virtual Vacationland is a resource tool to help elementary and secondary teachers and students find and use Earth science data and information on the Internet. Content is arranged by science topic. Each topic has a preview page that summarizes the material. Each topic also has 2 to 5 detail pages, which show where to access online data and what the data mean. The site includes over 40 hands-on activities available on the following science topics, with new topics being added as the site grows: Land Topography; Ocean Bathymetry; Coastal Tides; Ocean Buoy Data; Ocean Temperature; Weather and Climate; and Watersheds and Rivers. *Recommended for:* Elementary–secondary.

Windows to the Universe

http://www.windows.ucar.edu

Windows to the Universe brings together scientific content on Earth and space sciences with interdisciplinary content on the arts and humanities, in order to provide a rich educational tool that satisfies the curiosity of a wide spectrum of learners as they seek to understand our world and space around us. Three levels of content are provided: students (K–12 through undergraduate), teachers, and browsing adults. The site includes a rich array of documents, images, movies, animations, sounds, games, and data that brings science to life for students, teachers, and the interested user. *Recommended for:* K–12, informal education.

MIDDLE SCHOOL

The Adventure of Echo the Bat

http://imagers.gsfc.nasa.gov

An interactive Web site allowing students to follow Echo the Bat as he migrates through Arizona. The adventure offers a directed and investigative approach to how land features look from space, what the colors mean in a Landsat image, and an introduction to identifying habitats in a false color Landsat image. The site is supported with a teacher's guide that includes the following units: Understanding Light, Remote Sensing, and Biodiversity. *Recommended for:* Grades 5–8.

Data Discovery: The Amazon

http://www.planearthsci.com

This CD-ROM brings Earth system science concepts to life in the classroom by challenging your students to conduct modern ecosystem research as it really happens. The multimedia learning tool engages students in a research expedition on the Amazon River flood plain, where they apply

modern chemical techniques and evaluate satellite data to discover the role of the floodplain in the trophic ecology of Amazon River fishes. Developed by Planet Earth Science and available for purchase from www.amazon.com. *Recommended for:* Middle–high school.

Data Discovery: El Niño

http://www.planearthsci.com

This CD-ROM engages students in a journey where they must navigate their own ship, operate modern research tools, and manipulate satellite and climate model data to investigate and help predict El Niño—one of our planet's largest global climactic disruptions. Developed by Planet Earth Science and available for purchase from www.amazon.com. *Recommended for:* Middle–high school.

Data Discovery: Ozone

http://www.planearthsci.com

In this adventure, middle-school students are "hired" to determine if the size of the Antarctic ozone hole is increasing. They set sail on the Research Vessel Glomar, this time in Antarctica, where they embark on their own investigation following the scientific method by testing a given hypothesis. To assist them, satellite images of ozone concentration and instructional movies are located onboard the ship. Developed by Planet Earth Science and available for purchase from www.amazon.com *Recommended for:* Middle–high school.

DataSlate

http://casde.jpl.nasa.gov/dataslate

DataSlate is a multi-curricular image visualization tool for students. It allows students to easily and quickly maneuver through huge image data sets, overlay and compare images gathered over time, or with different instruments, and observe historical, geographical, geological, and environmental change or to compare images of the same area at different wavelengths. DataSlate includes a CD-ROM (with 12 sample data sets and 12 sample lesson plans), video, and teachers' guide. *Recommended for:* Middle–high school.

Discover Earth Classroom Materials

http://www.strategies.org/CLASS.html

Discover Earth classroom materials were developed during a series of teacher workshops sponsored by NASA and implemented by the Institute for Global Environmental Strategies in collaboration with the Department of Meteorology, University of Maryland, College Park, and the Earth and Mineral Sciences Environmental Institute, The Pennsylvania State University. Modules include: Earth as a System; Albedo versus Temperature; Ozone; and Where Does the Rain Go? Each module includes: Key Concepts and Terms; Resources; Background for Teachers; and Classroom Investigations. *Recommended for:* Grades 5–12.

Dr. Art's Guide to Planet Earth

http://www.planetguide.net

Dr. Art's Guide to Planet Earth explains the Earth system using three concepts: 1. The cycles of matter; 2. The flows of energy; and 3. The web of life. The Guide then applies these concepts to real-life problems and issues that affect us and our planet. Developed by WestEd, Dr. Art's guide is available for purchase on the Web site above. *Recommended for:* Middle+.

Earth & Sky

http://earthsky.com

Earth & Sky (E&S) and NASA's Earth Science Enterprise have collaborated on a series of 90-second radio programs highlighting ESE science, with scientists participating from Goddard Space Flight Center and Jet Propulsion Laboratory. The E&S radio series programs are produced for a measured audience of more than 3.8 million listeners (weekly). The E&S Web site contains links to the audio and text files for all E&S shows, as well as links to related educational resources. *Recommended for:* K–12 and informal education.

Earth Update

http://earth.rice.edu/connected/earthupdate.html
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Rice Space Institute developed this CD-ROM, which contains Earth science information, movies, and classroom activities. The CD is suitable as a stand-alone museum kiosk or for use in a school classroom or library. If the user's computer is connected to the Internet, today's data can be downloaded with a single click. Each "sphere" (Atmosphere, Biosphere, Cryosphere, Geosphere, and Hydrosphere) can be run separately or as the linked Earth Update. Each sphere includes sections What (What is the atmosphere), Who (Who studies the biosphere), Why (Why do we study the cryosphere?), and How (How do we study the geosphere?). Classroom activities aligned with national science, math, and geography standards are included on the CD. *Recommended for:* K–12 and informal education.

Event-Based Science (EBS): Remote-Sensing Activities and other Modules

http://www.mcps.k12.md.us/departments/eventscience/rs.index.html

EBS/Remote-Sensing Activities enable middle school students to use remotely-sensed data—especially products from NASA sensors—as they tackle the real-world problems and tasks found in existing EBS modules. Remotely-sensed data are employed as an integral part of both the presentation of Earth system science concepts, and in the solutions to real-world problems. These activities emphasize the use of NASA remote-sensing data. The EBS remote-sensing activities enhance EBS modules, including: Blight! Earthquake! Fire! Flood! Hurricane! Oil Spill! and Volcano! *Recommended for:* Grades 5–8.

Exploring Earth from Space: Lithograph Set and Instructional Materials, LS-1999-05-001-HQ

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Online, problem-based modules developed by NASA's Classroom of the Future for K–4,5–8, and 9–12 teachers and students. Modules address events such as volcanoes, hurricanes, dinosaur extinction theories, deforestation, endangered species, and global change. *Recommended for:* K–12.

Exploring Wetlands with Satellite Sensing and Exploring Remote Sensing: A Hands-on Experience

http://baby.indstate.edu/gerstt/handson.html

In Exploring Wetlands, principles of remote sensing and examples of environmental applications using remote sensing present the background required for the hands-on CD. Exploring Remote Sensing provides digital remote-sensing data of several small study areas from various environments such as wetlands and volcanoes. *Recommended for:* Grades 7–12.

From a Distance: An Introduction to Remote Sensing/GIS/GPS

http://education.ssc.nasa.gov/ltp

This Web site was developed and is maintained by NASA John C. Stennis Space Center. It includes lesson plans on remote sensing for Grades K–3, 4–8, and 9–12 and links to related education resources. *Recommended for:* K–12.

GLOBE

http://globe.fsl.noaa.gov

Students from all over the world are participating in the Global Learning and Observations to Benefit the Environment (GLOBE) program by taking daily environmental measurements at their schools and sharing their data via the Internet. Some features on this Web site are specially designed and available only to GLOBE teachers and students who are trained in GLOBE measurement procedures. However, most features are available to anyone wanting to learn more about GLOBE, review the scientific areas of GLOBE study, read the GLOBE Teachers' Guide, and access student data. *Recommended for:* Elementary–high school.

Metropolitan East Coast (MEC) Assessment Educators Pack

http://metroeast_climate.ciesin.columbia.edu/edumod.html

The MEC assessment was one of 18 regional assessments of climate change and variability organized by the U.S. Global Change Research Program. The MEC Educator's Pack contains geographic information system (GIS) software, data sets, and lesson plans designed for educators who are interested in using GIS technology to explore global climate change issues. The package includes a free GIS software program called ArcExplorer by ESRI, the world's leading GIS software developer. ArcExplorer is easy to use and comes with a user manual to help get you started. Also provided are two lesson plans that use ArcExplorer to view the data and produce a series of maps to study climate change predictions in the MEC region. *Recommended for:* Middle–high school.

Mission Geography

http://missiongeography.org

Mission Geography is curriculum support materials that link the content, skills, and perspectives of Geography for Life: The National Geography Standards with the mis-

sions, research, and science of NASA. Developed by the Geography Education National Implementation Project (GENIP) at Texas A&M University. *Recommended for:* K–12.

The Potential Consequences of Climate Variability and Change

http://www.strategies.org/CLASS.html

This set of inquiry-based, classroom-ready activities for grades 1–12 includes 12 modules. Produced to provide an overview of climate change, these modules also examine the relationship of climate change to areas such as agriculture, coastal areas, forestry, human health, and water. They contain activities developed with the purpose of introducing students to current research about the potential impacts of climate variability and change. Each activity responds to national education standards in the English language arts, geography, social studies, mathematics, and science. *Recommended for:* Grades 1–12.

SkyMath: Mathematics for a Blue Planet

http://www.unidata.ucar.edu/staff/blynds/Skymath.html

The University Corporation for Atmospheric Research (UCAR) received funding from the National Science Foundation to prepare SkyMath,a set of middle school mathematics modules incorporating weather data. SkyMath requires teachers and students to acquire and use current environmental and real-time weather data in ways that embrace the dynamic and uncertain natures of these data, in order to promote the teaching and learning of significant mathematics, consistent with the standards set by the National Council of Teachers of Mathematics. The SkyMath modules may be freely downloaded from the Internet. *Recommended for:* Grades 5–8.

Students' Cloud Observations Online (S'COOL)

http://scool.larc.nasa.gov

S'COOL is a component of NASA's Clouds and the Earth's Radiant Energy System (CERES) project, which is providing global data on clouds. S'COOL participants make ground truth measurements for the CERES experiment, which are land-based observations to compare with satellite data for the purpose of improving the satellite results. The S'COOL Web site provides information on the project and how to participate, as well as classroom materials and resources. *Recommended for:* Grades 3–12.

teachearth.com

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Searchable Web site with links to classroom materials and resources for teaching and learning about Earth system science. Users can search by grade level and subject. Developed by the Institute for Global Environmental Strategies. *Recommended for:* K–12.

Understanding the Biosphere from the Top Down

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This Web site contains a 22-lesson package written by eight local teachers working with the advice and help of NASA Ames Research Center personnel in Earth Sciences. The lessons focus on studying the biosphere from space to teach students about the Earth system. *Recommended for:* Grades 4–12.

Virtual Vacationland

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Visit to an Ocean Planet

http://topex-www.jpl.nasa.gov/education/cdrom.html
http://core.nasa.gov

Interactive, educational CD-ROM that reveals the importance of our oceans to global climate and life. Allows users to explore the Gulf of Mexico with satellite data, investigate the 1997–98 El Niño, discover "what's up" with Earth-orbiting satellites, and learn about the research activities of real life oceanographers. The curriculum background materials are arranged in the context of widely accepted teaching themes. The CD-ROM also highlights results from NASA's TOPEX/POSEIDON satellite. Available from NASA CORE. *Recommended for:* Grades 5–l2.

Windows to the Universe

http://www.windows.ucar.edu

Windows to the Universe brings together scientific content on Earth and space sciences with interdisciplinary content on the arts and humanities, in order to provide a rich educational tool that satisfies the curiosity of a wide spectrum of learners as they seek to understand our world and space around us. Three levels of content are provided: students (K–12 through undergraduate), teachers, and browsing adults. The site includes a rich array of documents, images, movies, animations, sounds, games, and data that brings science to life for students, teachers, and the interested user. *Recommended for*: K–12, informal education.

World Watcher: Global Warming Project

http://www.worldwatcher.northwestern.edu

Global warming and its potential impact provide the context for this unit, in which students learn about the scientific factors contributing to the debate. Students act as advisors to the heads of state of several nations, and explore the issues as they respond to the various questions and concerns of these leaders. Activities include a combination of physical labs and investigations using World Watcher software, a geographic data visualization tool. Developed by Northwestern University. *Recommended audience:* Middle school+.

HIGH SCHOOL

Arctic Observatory/Sea Ice in the Polar Regions

http://core.nasa.gov

The Arctic Observatory includes a teacher's guide and interactively deals with Arctic phenomena and processes, allowing students to ask and answer questions about interrelationships between several physical aspects of the Arctic system. Sea Ice in the Polar Regions is a presentation that describes sea ice classification, observation and climate impacts. Both resources are available on one CD-ROM from NASA CORE; they can also be downloaded at: http://www.usra.edu/esse/learnmod.html. *Recommended for:* High school–adult.

Asian Monsoon CD-ROM

http://dao.gsfc.nasa.gov/sci_highlights/monsoon_cd
http://core.nasa.gov

This interactive, student-centered CD-ROM for studying global climate patterns focuses on the Asian monsoon season. Students are guided through an investigative journey studying weather and climate patterns and their effects on the local and world environments. *Recommended for:* High school.

CEOS Resources in Earth Observation

http://ceos.cnes.fr:8100/cdrom-98/astart.htm

The international Committee on Earth Observation Satellites (CEOS) has produced this CD/Web site, which contains case studies (examples of applications of Earth observation to various real-life situations and problems), data and information for education and developing countries. *Recommended for:* High school, undergraduate, graduate–professional.

Climate Change Presentation Kit, 1999

http://core.nasa.gov

This CD-ROM is offered as a resource to help prepare talks for students or the general public. The toolkit allows teachers the option of picking and choosing the components that they would need to communicate climate change issues to audiences. It contains fact sheets, a PowerPoint slide presentation, and interactive activities that are designed to interest audiences of all levels. Available from NASA CORE. *Level:* Elementary–college educators.

Data Discovery: The Amazon

http://www.planearthsci.com

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From a Distance: An Introduction to Remote Sensing/GIS/GPS

http://education.ssc.nasa.gov/ltp

This Web site was developed and is maintained by NASA John C. Stennis Space Center. It includes lesson plans on remote sensing for grades K–3, 4–8, and 9–12 that were developed by professional educators and links to related education resources. *Recommended for:* K–12.

Geomorphology from Space, 1986

http://daac.gsfc.nasa.gov/DAAC_DOCS/geomorphology/GEO_HOME_PAGE.html
http://core.nasa.gov

An out-of-print NASA classic publication, by Nick Short, Sr. and Robert W. Blair, Jr., is now available on CD-ROM and on the Web. This publication is designed for use by the remote-sensing science and educational communities to study landforms and landscapes. It contains a gallery of 237 color, and black and white plates of space imagery primarily of the Earth, each treating a geographic region where a particular landform theme is exemplified. Each image is paired with a detailed scientific description of the features in the image; some images are accompanied by line drawings, locator maps, geologic maps, and on-the-ground photographs of the landform. Available on the Web or on CD-ROM from NASA CORE. *Recommended for:* High school–adult.

Global Systems Science (GSS)

http://www.lhs.berkeley.edu/GSS

The GSS Student Books, developed at the Lawrence Hall of Science, can be combined in various ways to create an interdisciplinary high school course. In the GSS approach, students integrate the traditional disciplines to probe the interactions among the atmosphere, ocean, ice, solid Earth, and living organisms that shape Earth's evolution and its future. Students study the traditional disciplines, not as ends in themselves, but as tools for a scientific understanding of Earth as an integrated system. The following GSS books have been approved by NASA's Earth Science Enterprise:

- GSS Teachers' Guide
- New World View
- Climate Change
- Losing Biodiversity
- Energy Flow

Recommended for: Grades 9–12.

GLOBE Program

http://globe.fsl.noaa.gov

Students from all over the world are participating in the Global Learning and Observations to Benefit the Environment (GLOBE) program by taking daily environmental measurements at their schools and sharing their data via the Internet. Some features on this Web site are specially designed and available only to GLOBE teachers and students who are trained in GLOBE measurement procedures. However, most features are available to anyone wanting to learn more about GLOBE, review the scientific areas of GLOBE study, read the GLOBE Teachers' Guide, and access student data. *Recommended for:* Elementary–high school.

Into the Arctic: Information and Education Activities for Studying Climate

http://arcss.colorado.edu/data/arcss069.html

The University of Colorado/CIRES developed this CD-ROM on climate and climate history in the Arctic, which uses real data and questions from the Greenland Ice Sheet Project Two (GISP2). *Recommended for:* Grades 9–12.

Mission Geography

http://missiongeography.org

Mission Geography is curriculum support materials that link the content, skills, and perspectives of Geography for Life: The National Geography Standards with the missions, research, and science of the National Aeronautics and Space Administration (NASA). Developed by the Geography Education National Implementation Project (GENIP) at Texas A&M University. *Recommended for:* K–12.

The Potential Consequences of Climate Variability and Change

http://www.strategies.org/CLASS.html

This set of inquiry-based, classroom-ready activities for grades 1-12 includes 12 modules. Produced to provide an overview of climate change, these modules also examine the relationship of climate change to areas such as agriculture, coastal areas, forestry, human health, and water. They contain activities developed with the purpose of introducing students to current research about the potential impacts of climate variability and change. Each activity responds to national education standards in the English language arts, geography, social studies, mathematics, and science. *Recommended for:* Grades 1–12.

Students' Cloud Observations Online (S'COOL)

http://scool.larc.nasa.gov

S'COOL is a component of NASA's Clouds and the Earth's Radiant Energy System (CERES) project, which is providing global data on clouds. S'COOL participants make ground truth measurements for the CERES experiment, which are land-based observations to compare with satellite data for the purpose of improving the satellite results. The S'COOL Web site provides information on the project and how to participate, as well as classroom materials and resources. *Recommended for:* Grades 3–12.

Studying Earth's Environment from Space

http://see.gsfc.nasa.gov/edu/SEES

This material consists of four modules: Stratospheric Ozone; Global Land Vegetation; Oceanography; and Polar Sea Ice Processes. The modules are designed to increase the use of satellite data in science classrooms by providing lecture materials in HTML for the classroom (including full-color, printable graphics) that are linked to guided-inquiry computer exercises. The current software package used for the computer exercises is a modified version of the Macintosh platform's NIH-Image. This software, called SEE Image, also has been tested and runs on a PC that is equipped with a Macintosh emulator. *Recommended for:* High school–undergraduate.

teachearth.com

http://teachearth.com

Searchable Web site with links to classroom materials and resources for teaching and learning about Earth system science. Users can search by grade level and subject. Developed by the Institute for Global Environmental Strategies. *Recommended for:* K–12.

Understanding the Biosphere from the Top Down

http://geo.arc.nasa.gov/sge/jskiles/top-down/intro_product/title-page.html

This Web site contains a 22-lesson package written by eight local teachers working with the advice and help of NASA Ames Research Center personnel in Earth Sciences. The lessons focus on studying the biosphere from space to teach students about the Earth system. *Recommended for:* Grades 4–12.

Virtual Vacationland

http://www.bigelow.org/virtual

Virtual Vacationland is a resource tool to help elementary and secondary teachers and students find and use Earth science data and information on the Internet. Content is arranged by science topic. Each topic has a preview page that summarizes the material. Each topic also has 2 to 5 detail pages, which show where to access online data and what the data mean. The site includes over 40 hands-on activities available on the following science topics, with new topics being added as the site grows: Land Topography; Ocean Bathymetry; Coastal Tides; Ocean Buoy Data; Ocean Temperature; Weather and Climate; and Watersheds and Rivers. *Recommended for:* Elementary–secondary.

Visit to an Ocean Planet

http://topex-www.jpl.nasa.gov/education/cdrom.html

1998, interactive, educational CD-ROM that reveals the importance of our oceans to global climate and life. Allows users to explore the Gulf of Mexico with satellite data, investigate the 1997–98 El Niño, discover "what's up" with Earth-orbiting satellites, and learn about the research activities of real life oceanographers. The curriculum background materials are arranged in the context of widely accepted teaching themes. The CD-ROM also highlights results from NASA's TOPEX/POSEIDON satellite. Available from NASA CORE (Item #400.0-92). *Recommended for:* Grades 5–l2.

Windows to the Universe

http://www.windows.ucar.edu

Windows to the Universe brings together scientific content on Earth and space sciences with interdisciplinary content on the arts and humanities, in order to provide a rich educational tool that satisfies the curiosity of a wide spectrum of learners as they seek to understand our world and space around us. Three levels of content are provided: students (K–12 through undergraduate), teachers, and browsing adults. The site includes a rich array of documents, images, movies, animations, sounds, games, and data that brings science to life for students, teachers, and the interested user. R*ecommended for:* K–12, informal education.

World Watcher: Global Warming Project

http://www.worldwatcher.northwestern.edu

Global warming and it potential impact provide the context for this unit, in which students learn about the scientific factors contributing to the debate. Students act as advisors to the heads of state of several nations, and explore the issues as they respond to the various questions and concerns of these leaders. Activities include a combination of physical labs and investigations using World Watcher software, a geographic data visualization tool. Developed by Northwestern University. *Recommended audience:* Middle school+.

POSTSECONDARY

CERES—Clouds and the Earth's Radiant Energy System Brochure

http://eospso.gsfc.nasa.gov/eos_homepage/misc_html/ceres.html

This brochure gives a brief description of the science research that is being done with data from the CERES instrument flying onboard NASA's Terra satellite. It also contains some of the data products, as well as gives some technical specifications. *Recommended for:* Undergraduate, graduate, professional.

DAAC's Supporting Earth Observing Science Yearbook

http://nasadaacs.eos.nasa.gov/yearbooks/index.html

NASA's eight Distributed Active Archive Centers (DAAC) located across the U.S. deliver relevant, critical, and timely data that underpin crucial research and understanding of Earth. The DAACs distribute science data from both heritage and current NASA satellite missions that include NASA in-situ field campaigns and satellite missions flown by other U.S. Government agencies and international partners. Currently the DAACs provide data management support for over 900 science data sets that are routinely requested by members of the science research and educational communities, commercial entities, museums, and the general public. *Recommended for:* High school, undergraduate, graduate–professional.

Earth from Above: Using Color-Coded Satellite Images to Examine the Global Environment, 1997

http://www.uscibooks.com

Written by NASA Goddard Space Flight Center scientist Claire Parkinson, Earth from Above provides an easy introduction to understanding and interpreting satellite images. Beginning with two short chapters on visible satellite images and radiation, the book then covers six key Earth-atmosphere variables on such environmentally important topics as the Antarctic ozone hole, El Niño, deforestation, the missing carbon dilemma, and the effects of sea ice, snow cover, and volcanoes on atmospheric temperatures. A final chapter broadens the discussion to consider satellite Earth observations in general. Each section concludes with a list of questions; answers are provided at the back of the book. Available for purchase from University Science Books.

Earth System Science Online Courses for K–12 Teachers

http://www.cet.edu/essea

K–12 Earth system science (ESS) online graduate courses have been developed within the Center for Educational Technology (CET) at Wheeling Jesuit University for NASA's Earth Science Enterprise. The Earth system science courses use an innovative instructional design model, are delivered over the Internet, and feature student-centered, knowledge-building virtual communities. These courses are available for universities, colleges, and other science education training organizations to use. To view the courses, use "cet" as the user name and password.

Ecosystem Change and Public Health Textbook

http://www.press.jhu.edu/press/books/titles/s01/s01arec.htm

This textbook was published by Johns Hopkins University Press to: 1) raise awareness of changes in human health related to global ecosystem change; and 2) expand the scope of the traditional curriculum in environmental health to include the interactions of major environmental forces and public health on a global scale. The book covers such topics as global climate change, stratospheric ozone depletion, water resources management, and ecology and infectious disease. Case studies of cholera, malaria, the effects of water resources, and global climate change and air pollution illustrate the analysis and methodology. The book also includes a resource center describing places to start searches on the Web, guidelines for finding and evaluating information, suggested study projects, and strategies for encouraging communication among course participants. *Recommended for:* Undergraduate.

EOS Science Plan, 1999

http://eospso.gsfc.nasa.gov/sci_plan/chapters.html

Within this publication, the reader will find types and quality of data that will be produced from NASA Earth Observing System (EOS) satellite observations, how they will improve over existing measurements, and how the data will be applied to solving the problems described. Seven topical chapters discuss the nature of the science being reviewed: radiation, clouds, water vapor, precipitation, and atmospheric circulation; ocean circulation, productivity, and exchange with the atmosphere; greenhouse gases and atmospheric chemistry;

land ecosystems and hydrology; cryospheric systems; ozone and stratospheric chemistry; and volcanoes and climate effects of aerosols.

Geomorphology from Space, 1986

http://daac.gsfc.nasa.gov/DAAC_DOCS/geomorphology/GEO_HOME_PAGE.html
http://core.nasa.gov

An out-of-print NASA classic publication, by Nick Short, Sr. and Robert W. Blair, Jr., is now available on CD-ROM and on the Web. This publication is designed for use by the remote-sensing science and educational communities to study landforms and landscapes. It contains a gallery of 237 color, and black and white plates of space imagery primarily of the Earth, each treating a geographic region where a particular landform theme is exemplified. Each image is paired with a detailed scientific description of the features in the image; some images are accompanied by line drawings, locator maps, geologic maps, and on-the-ground photographs of the landform. Available on CD-ROM from NASA CORE. *Recommended for:* High school–adult.

Measurements of Pollution in the Troposphere (MOPITT) Brochure

http://eospso.gsfc.nasa.gov/eos_homepage/misc_html/mopitt.html

This brochure gives a brief description of the science research that is being done with data from the MOPPITT instrument flying onboard NASA's Terra satellite. It also contains some of the data products, as well as gives some technical specifications. *Recommended for:* Undergraduate, graduate–professionals.

Remote Sensing Core Curriculum

http://www.umbc.edu/rscc

The Remote Sensing Core Curriculum (RSCC), sponsored by the International Center for Remote Sensing Education (ICRSE), NASA, and the American Society for Photogrammetry and Remote Sensing (ASPRS) is an education program developed in cooperation with international experts and businesses to ensure an authoritative and substantive curriculum in remote sensing. The curriculum includes a series of lecture outlines, accompanied by self-contained laboratory exercises developed to support the advancing technologies of remote sensing and its integration with spatial information systems. Digital data sets from existing and planned satellite missions will enhance the understanding of advanced concepts. The RSCC design will ensure full access to data sets, operating software, and lecture materials via the RSCC home page.

The Remote Sensing Tutorial

http://rst.gsfc.nasa.gov

This CD-ROM is a tutorial approach to learning about the role of space science and technology in monitoring the Earth's surface and atmosphere. As you work through the tutorial, you will come to understand how remote sensing is applied to studying the land, sea, and air making up the environments of our planet. Not only will you gain insight into past uses of aerial photography and space imagery as records of the Earth's geography as well as the future plans for more advanced monitoring systems, but you should develop skills in interpreting these visual displays and data sets both by direct inspection and by computer processing. The CD-ROM, current as of early 1999, is available from NASA CORE. The latest version of the tutorial is available to download online from: http://rst.gsfc.nasa.gov *Recommended for:* College and remote-sensing professionals.

Studying Earth's Environment from Space

http://see.gsfc.nasa.gov/edu/SEES

This material consists of four modules: Stratospheric Ozone; Global Land Vegetation; Oceanography; and Polar Sea Ice Processes. The modules are designed to increase the use of satellite data in science classrooms by providing lecture materials in HTML for the classroom (including full-color, printable graphics) that are linked to guided-inquiry computer exercises. The current software package used for the computer exercises is a modified version of the Macintosh platform's NIH-Image. This software, called SEE Image, also has been tested and runs on a PC that is equipped with a Macintosh emulator. *Recommended for:* High school–undergraduate.

World Watcher: Global Warming Project

http://www.worldwatcher.northwestern.edu

Global warming and its potential impact provide the context for this unit, in which students learn about the scientific factors contributing to the debate. Students act as advisors to the heads of state of several nations, and explore the issues as they respond to the various questions and concerns of these leaders. Activities include a combination of physical labs and investigations using World Watcher software, a geographic data visualization tool. Developed by Northwestern University. *Recommended audience:* Middle school+.

INFORMAL EDUCATION

Earth Observatory

http://earthobservatory.nasa.gov

Web site where the public can obtain new satellite imagery and scientific information about Earth, focusing on climate and environmental change. Visit the Earth Observatory to read feature articles on wide-ranging Earth system science topics, as well as see the latest images, media alerts, and summaries of Earth science headlines from radio, newspaper, and television. The Experiments section includes classroom activities and experiments.

Earth & Sky

http://earthsky.com

Earth & Sky (E&S) and NASA's Earth Science Enterprise have collaborated on a series of 90-second radio programs highlighting ESE science, with scientists participating from Goddard Space Flight Center and Jet Propulsion Laboratory. The E&S radio series programs are produced for a measured audience of more than 3.8 million listeners (weekly). The E&S Web site contains links to the audio and text files for all E&S shows, as well as links to related educational resources. *Recommended for:* K–12 and informal education.

Earth Update

http://earth.rice.edu/connected/earthupdate.html
http://core.nasa.gov

Rice Space Institute developed this CD-ROM, which contains Earth science information, movies, and classroom activities. The CD is suitable as a stand-alone museum kiosk or for use in a school classroom or library. If the user's computer is connected to the Internet, today's data can be downloaded with a single click. Each "sphere" (Atmosphere, Biosphere, Cryosphere, Geosphere, and Hydrosphere) can be run separately or as the linked Earth Update. Each sphere includes sections What (What is the atmosphere), Who (Who studies the biosphere), Why (Why do we study the cryosphere?), and How (How do we study the geosphere?). Classroom activities aligned with national science, math, and geography standards are included on the CD. Also available from NASA CORE. *Recommended for:* K–12 and informal education.

NASA's Earth Observing System—Global Change Media Directory 2001

http://dougb.gsfc.nasa.gov:591/eobsearch.html

This publication contains an alphabetical list of NASA Earth Observing System researchers, with contact information, and their areas of expertise. It also contains indices for areas of expertise, location, as well as media resources and public affairs contacts. Online Version is titled: Global Change Experts Directory. *Recommended for:* Broadcast and print media; also useful for formal and informal education product developers (e.g., references for information).

Science Writers Guide to Landsat-7

http://landsat.gsfc.nasa.gov/main/PDF/Landsat7_writer_guide.pdf

Landsat 7 is advancing several areas of Earth science, including monitoring croplands and mapping Antarctic ice streams. This guide profiles several Landsat 7 research projects and provides background and contact information. *Recommended for:* Science writers/media.

Science Writers Guide to Terra

http://earthobservatory.nasa.gov/Newsroom/MediaResources/Terra_Writers_Guide.pdf

The launch of NASA's Terra spacecraft marked a new era of comprehensive monitoring of the Earth's atmosphere, oceans, and continents from a single space-based platform. Data from the 5 Terra instruments are creating continuous, long-term records of the state of the land, oceans, and atmosphere. Together with data from other satellite systems launched by NASA and other countries, Terra will inaugurate a new self-consistent data record that will be gathered over the next 15 years. This guide provides research profiles, as well as extensive background and contact information for Terra. *Recommended for:* Science writers/media.

Space Place

http://spaceplace.jpl.nasa.gov

NASA Jet Propulsion Laboratory Web site geared for elementary age children. The site provides fun activities for children to do and make, while they learn about space and Earth science, and the technology that enables science. The"Teachers Corner" on the Web site contains curriculum supplements originally published in the ITEAS' Technology Transfer Teacher magazine. *Recommended for:* Elementary-age children.

Visible Earth

http://visibleearth.nasa.gov

This companion site to the NASA Earth Observatory is a comprehensive image gallery for access to NASA Earth science images, animations, and data visualizations. Most resources are available digitally at multiple resolutions, with captions and metadata. All resources are full-text search-and-retrievable. *Recommended for:* General audiences.

Windows to the Universe

http://www.windows.ucar.edu

Windows to the Universe brings together scientific content on Earth and space sciences with interdisciplinary content on the arts and humanities, in order to provide a rich educational tool that satisfies the curiosity of a wide spectrum of learners as they seek to understand our world and space around us. Three levels of content are provided: students (K–12 through undergraduate), teachers, and browsing adults. The site includes a rich array of documents, images, movies, animations, sounds, games, and data that brings science to life for students, teachers, and the interested user. *Recommended for:* K–12, informal education.

EDUCATIONAL RESOURCES

The following resources can be useful for developing lesson plans, curriculum supplements, student research projects, and sources of NASA research information and imagery.

BOOKMARKS

Climate Change Bookmarks

Set of bookmarks developed by NASA Langley Research Center, including: Ozone; Biomass Burning, Volcanic Aerosols, Clouds, and Human and Natural Impacts on the Earth. Each bookmark provides a Web address for additional information. Available online at: http://asd-www.larc.nasa.gov/ASDhomepage.html

LITHOGRAPHS

Lithographs contain a color image (e.g.,satellite image, artist's rendition of a spacecraft or instrument, etc.), with additional information and classroom activities or discussion questions. The following lithographs are available to download from NASA Spacelink: http://spacelink.nasa.gov/products or from your local NASA Educator Resource Center:

http://spacelink.nasa.gov/ercn

- *1997–1998 El Niño Lithograph* (LG-1998-05-004-GSFC)
- *Exploring Earth from Space* (LS-1999-05-001-HQ)
- *First Image of the Global Biosphere* (Hql-325)
- *Understanding Our Changing Planet* (HqL-430)
- *Water is a Force of Change* (Hql-401)
- *World Cloud Cover Pattern* (HqL-326)

BROCHURES

NASA's Earth Observing System: Terra Spacecraft

http://eospso.gsfc.nasa.gov/ftp_docs/Terra_brochure.pdf

This brochure gives a brief overview of the Earth science research that is being done with data from the instruments onboard NASA's Terra spacecraft.

NASA EARTH SCIENCE ENTERPRISE SCIENCE WRITING AND MULTIMEDIA TEAM

This team of science writers, science visualization professionals, and scientific illustrators examines NASA-conducted and sponsored Earth system science research for stories of broad appeal and interest to the public. They craft stories, create visual aids, and make the information and products available to the media and other parties. Archived stories, many of which have accompanying graphics, can be found at http://newsmedia.gsfc.nasa.gov. A searchable video catalog is available at the Goddard TV Web site http://www.gsfc.nasa.gov/gtv.html, and a gallery and searchable catalog of visualizations are available at http://newsmedia.gsfc.nasa.gov

CONTACT: Jim Closs, NASA Goddard Space Flight Center, *Phone:* 301-867-2116, Fax: 301-867-2149, *Email:* jim.closs@gsfc.nasa.gov—or: Anita Davis, Earth Science Enterprise Education Implementation Office, Goddard Space Flight Center, *Phone:* 301-286-8591, *Email:* adavis@see.gsfc.nasa.gov

NASA EARTH SCIENCE MISSIONS–EDUCATION

Many of NASA's Earth Science Missions have an education and public outreach component. These efforts include a wide variety of educational activities and resources for educators, students, and the public, such as teacher workshops, student activities, and public programs and events, as well as curriculum and classroom materials, and resources such as CD-

ROMs, posters, brochures, and videos. Visit the individual Web sites identified below for specific information on their programs and resources, including access to satellite imagery and other data. Missions are listed by year of launch.

- **TOPEX/Poseidon**
  http://sealevel.jpl.nasa.gov

  Jointly sponsored by NASA and the French Space Agency (CNES) the TOPEX/Poseidon satellite has used a radar altimeter to continuously survey ocean surface height since launch in 1992. TOPEX/Poseidon has been joined in orbit by its follow-on mission, Jason-1, which was launched in 2001.

  Scientists are using TOPEX/Poseidon and Jason-1 data, accurate to within 4 cm, to learn more about global ocean circulation patterns including phenomena such as the El Niño/La Niña cycle. Oceans are a key mechanism in transporting heat from the Sun around the globe. Researchers are working to improve the understanding of the role of oceans in controlling seasonal variations and longer-term climate changes. Ocean altimetry data are also used for operational purposes including ship routing, fisheries management, hurricane forecasting, and support of underwater activities such as cable laying. CONTACT: Annie Richardson, Jet Propulsion Laboratory; topex@jpl.nasa.gov (1992 Launch)

- **SeaWiFS**
  http://seawifs.gsfc.nasa.gov/SEAWIFS.html

  The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) is providing quantitative data on global ocean bio-optical properties. Subtle changes in ocean color signify various types and quantities of marine phytoplankton (microscopic marine plants), the knowledge of which has both scientific and practical applications. (1997 Launch)

- **Tropical Rainfall Measuring Mission (TRMM)**
  http://trmm.gsfc.nasa.gov—*click on link for "Educational Resources"*

  TRMM is a joint mission between NASA and the National Space Development Agency (NASDA) of Japan. It was designed to monitor and study tropical rainfall and the associated release of energy that helps to power the global atmospheric circulation shaping both weather and climate around the globe. CONTACT: Alan Nelson, Education Coordinator, NASA Tropical Rainfall Measuring Mission (TRMM), Education Department, Science Museum of Minnesota,120 West Kellogg Boulevard, St. Paul, Minnesota 55102; anelson@smm.org (1997 Launch)

- **ACRIMSAT**
  http://www.acrim.com

  A series of Active Cavity Radiometer Irradiance Monitors (ACRIMs) provides long-term, precise measurements of the total amount of the sun's energy that falls on our planet's surface, oceans, and atmosphere. (1999 Launch)

- **Landsat-7**
  http://landsat.gsfc.nasa.gov/main/education.html

  The Landsat-7 satellite is acquiring remotely-sensed images of land surface and coastal regions for global change research, regional environmental change studies, national security uses, and other civil and commercial purposes. The Landsat-7 data set will provide the first high-resolution view of both seasonal and interannual changes in the terrestrial environment. CONTACT: Stephanie Stockman, NASA Goddard Space Flight Center; stockman@core2.gsfc.nasa.gov (1999 Launch)

- **QuikScat/SeaWinds**
  http://winds.jpl.nasa.gov/missions/quikscat/quikindex.html

  The SeaWinds instrument on the QuikScat mission is a "quick recovery" mission to fill the gap created by the loss of data from the NASA Scatterometer (NSCAT), when the satellite lost power in June 1997. The SeaWinds instrument is a specialized microwave radar that measures near-surface wind speed and direction under all weather and cloud conditions over the Earth's oceans. (1999 Launch)

- **Terra**
  http://terra.nasa.gov

  Terra, the flagship of NASA's Earth Observing System, is collecting what will ultimately become a new, 15-year global data set on the state of the land, oceans, and atmosphere. CONTACT: David Herring, NASA Goddard Space Flight Center; dherring@climate.gsfc.nasa.gov (1999 Launch)

- **EO-1**
  http://eo1.gsfc.nasa.gov

  Earth Observing-1 (EO-1) is the first flight of NASA's New Millennium Program (NMP). Its mission is to validate technologies that will contribute to the reduction in cost of follow-on Landsat missions. (2000 Launch)

- **Jason-1**
  http://sealevel.jpl.nasa.gov

  The follow-on mission to TOPEX/Poseidon,scientists are using Jason-1 data to learn more about global ocean circulation patterns including phenomena such

as the El Niño/La Niña cycle. See TOPEX/Poseidon,1992 listing on page 77 for additional details. (2001 Launch)

METEOR 3M-1/SAGE III
http://www-sage3.larc.nasa.gov

The SAGE III mission on the Russian Meteor 3M-1 spacecraft seeks to enhance our understanding of natural and human-derived atmospheric processes by providing high latitude long-term measurements of the vertical structure of aerosols, ozone, water vapor, and other important trace gases in the upper troposphere and stratosphere. (2001 Launch)

Aqua
http://aqua.nasa.gov

Aqua, Latin for "water," is named for the large amount of information the mission will be collecting about the Earth's water cycle, including evaporation from the oceans, water vapor in the atmosphere, clouds, precipitation, soil moisture, sea ice, land ice, and snow cover on the land and ice. Additional variables measured by Aqua are radiative energy fluxes, aerosols, vegetation cover on the land, phytoplankton and dissolved organic matter in the oceans, and air, land, and water temperatures. CONTACT: Steve Graham, NASA Goddard Space Flight Center; graham@pop900.gsfc.nasa.gov (2002 Launch)

GRACE
http://essp.gsfc.nasa.gov/grace/index.html

The second of the Pathfinder missions, the Gravity Recovery and Climate Experiment (GRACE) employs a satellite-to-satellite microwave tracking system between two spacecraft to measure the Earth's gravity field and its time variability over five years. Such measurements are directly coupled to long-wavelength ocean circulation processes and to the transport of ocean heat to the Earth's poles. (2002 Launch)

ICESat
http://icesat.gsfc.nasa.gov—*click on link for "Public Outreach"*

The Ice, Cloud, and Land Elevation Satellite (ICESat) is a small satellite mission to fly the Geoscience Laser Altimeter System (GLAS). GLAS will accurately measure the elevation of the Earth's ice sheets, clouds, and land. (2002 Launch)

SORCE
http://lasp.colorado.edu/sorce

The Solar Radiation and Climate Experiment (SORCE) will provide scientists with long-term, accurate measurements of the solar ultraviolet (UV), far ultraviolet (FUV), and total irradiance from the sun. (2002 Launch)

SeaWinds on ADEOS II
http://winds.jpl.nasa.gov/missions/seawinds/seaindex.html

The Advanced Earth Observing Satellite II (ADEOS II), is a joint mission with the National Space Development Agency (NASDA) of Japan. The SeaWinds scatterometer is a specialized microwave radar that measures near-surface wind velocity (both speed and direction) under all weather and cloud conditions over Earth's oceans. (2002 Launch)

Aura
http://aura.gsfc.nasa.gov—*click on link for "Outreach"*

Aura will study the Earth's ozone, air quality and climate. This mission is designed exclusively to conduct research on the composition, chemistry and dynamics of the Earth's upper and lower atmosphere employing multiple instruments on a single satellite. CONTACT: Stephanie Stockman, NASA Goddard Space Flight Center; stockman@core2.gsfc.nasa.gov (2003 Launch)

CALIPSO
http://essp.gsfc.nasa.gov/calipso/index.html

CALIPSO (Cloud Aerosol Lidar and Infrared Pathfinder Satellite Observations) will improve our understanding of the role of aerosols and clouds in the processes that govern climate responses and feedbacks, and improve the representation of aerosols and clouds in models, leading to more accurate predictions of climate change. It will produce the first 3-dimensional view of aerosols and cloud profiles complementary to those of CloudSAT. CONTACT: Dianne Robinson, Public Outreach Director for CALIPSO, Hampton University; dianne.robinson@hamptonu.edu—or: Barbara Maggi, Public Outreach, Assistant Director for CALIPSO, Hampton University; barbara.maggi@hamptonu.edu (2004 Launch)

CloudSAT
http://cloudsat.atmos.colostate.edu/—*click on link for "Outreach"*

CloudSat will provide vertical cloud profiling from space of the full range of clouds from thin cirrus to thick, precipitating convective clouds. It will also provide the first quantitative estimates of ice in clouds. The mission will fill a critical gap in the investigation of feedback mechanisms linking clouds to climate. CloudSat will orbit in formation as part of a constellation of satellites including Aqua, Aura, and CALIPSO. A unique feature that CloudSat brings to this constellation is the ability to fly a precise orbit,

enabling the footprint of CloudSat radar to be overlapped with the CALIPSO lidar footprint, as well as the other measurements of the constellation. The precision of this overlap creates a unique multi-satellite observing system for studying the atmospheric processes essential to the hydrological cycle. CONTACT: Debra Krumm, Outreach Coordinator, Department of Atmospheric Science, Colorado State University, Fort Collins, CO 80523-1371; *Email:* dkrumm@atmos.colostate.edu (2004 Launch)

GIFTS
http://tellus.ssec.wisc.edu/outreach/gifts/gifts.htm

The Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS) will make revolutionary advances in weather observations and potentially improve weather forecast skills considerably by making high vertical and horizontal measurements of winds, water vapor, and temperature in the Earth's atmosphere from a geosynchronous altitude (36,000 km above the Earth's surface). CONTACT: Arlene Levine, NASA Langley Research Center, a.s.levine@express.larc.nasa.gov (2004 Launch)

NASA FACTS

NASA Facts are educational brochures that provide general information and background on NASA-related missions, research topics, and activities. The following Earth science NASA Facts are available online at: http://eospso.gsfc.nasa.gov/eos_homepage/misc_html/nasa_facts.html

- *Clouds and the Energy Cycle*—NF-207, August 1999
- *El Niño*—NF-211, August 1999
- *Global Warming*—NF-222, April 1998
- *NASA Earth Science Enterprise Images and Video via the World Wide Web*—FS-1998-02-007-GSFC, November 1998
- *Polar Ice*—NF-212, April 1998
- *Tropical Deforestation*—FS-1998-11-120-GSFC, November 1998

NEWSLETTER

Earth Science Enterprise Education Update

A free, monthly email newsletter, which contains information on NASA Earth science education activities, research announcements, current science news, and calendar of upcoming education events. To subscribe, please send email to: ese_ed_newsletter@listserv.gsfc.nasa.gov. Back issues are available at: http://www.earth.nasa.gov/education/edreports/index.html

POSTERS

From the Top of the World to the Bottom of the Food Web
http://www.bigelow.org/foodweb

This educational wall sheet and associated Web site were developed by Bigelow Laboratory for Ocean Sciences to help teachers and students discover linkages among marine ecology, phytoplankton, the behavior of light at the ocean surface, and satellite derived ocean color data. *Recommended for:* Middle school+ .

Rise and Fall of the 97–98 El Niño as Tracked by the TOPEX/POSEIDON
EW-1998-11-004-JPL
http://topex-www.jpl.nasa.gov/education/el-nino-poster.html

Color satellite images from NASA's TOPEX/POSEIDON mission illustrate this poster, which tracks the 1997–98 El Niño. The reverse side of the poster contains black and white, reproducible pages with information and classroom activities. Information and classroom activities contained on the poster are available in PDF format at the Web site listed above.

SeaWiFS Poster with Teaching Supplement
http://seawifs.gsfc.nasa.gov/SEAWIFS/TEACHERS

Poster with remote-sensing images from NASA's Sea-viewing Wide Field-of-View Sensor (SeaWiFS). The teaching supplement augments the poster with descriptive summaries of the variety of geophysical phenomena that can be seen in each image. The supplement also includes a glossary of terms and a listing of URLs for additional information. *Recommended for:* Upper high school–undergraduate

VIDEOTAPES

The following are selected videotapes related to NASA's Earth Science Program, which are available for purchase from NASA CORE at: http://core.nasa.gov

Catch the Wind: the QuikSCAT Video, 2001

Video that tells the story from inception to launch of NASA's quick scatterometer project (QuikSCAT), which gives a behind-the-scenes look at engineers, scientists, and technicians working together to solve problems and successfully accomplish goals. Length:25:22. *Recommended for:* Middle school–adult.

NASA Connect: Data Analysis, and Measurement—Ahead, Above the Clouds, 2001

NASA CONNECT is a series of free, 30-minute, standards-based instructional distance learning programs for students in grades 5–8. Each program is accompanied by an educators' guide describing a hands-on classroom activity, and a Web-based component that reinforces the learning objectives and extends the lesson into a technology-rich environment. In "Ahead, Above the Clouds" students learn about hurricanes and how meteorologists, weather officers, and NASA researchers use measurement and data analysis to predict severe weather such as hurricanes. Length:30:00. *Recommended for:* Middle school.

Glacier Bay, Alaska, From the Ground, Air and Space, 1996

Brings glaciers to life with nine spectacular "fly-bys" of scenic rides over 3-dimensional glaciers, live video footage of ice fronts calving into the sea, and dramatic picture sequences of historical and satellite data, and shows how a NASA glaciologist has learned about glaciers and how their formation could be related to climate change. In addition to NASA CORE, this video is also available online at: http://sdcd.gsfc.nasa.gov/GLACIER.BAY/glacierbay.story.html. Length:13:15. *Recommended for:* Grade 5–adult.

Jason: An Ocean Odyssey Video, 2001

Jason is joint U.S.-France oceanography mission to monitor global ocean circulation, discover the tie between the oceans and atmosphere, improve global climate predictions, and monitor events such as El Niño conditions and ocean eddies. Jason-1 is a follow-on mission to the highly successful TOPEX/Poseidon mission. Length: 9:00. *Recommended for:* Grade 5–adult.

SunSplash, 1997

Explains ozone depletion, using computer graphics and animation. The educational narrative explains how ozone in the stratosphere protects us from ultraviolet radiation and demonstrates how chlorofluorocarbons (CFCs) cause destruction of the Earth's protective ozone layer. Length: 7:52. *Recommended for:* Grades 9–12.

UARS—The Upper Atmosphere Research Satellite Video and Resource Guide, 2001

This videotape was created to be a resource for helping to understand stratospheric ozone. The instruments aboard the UARS and their measurements are described in the tape and how they help in studying humankind's influence on ozone. *Recommended for:* High school–undergraduate.

WEB SITES

Astronaut Photos of Earth

http://eol.jsc.nasa.gov

The Earth Science home page provides access to the database of the Office of Earth Science/Johnson Space Center containing records of the location and description of over 350,000 astronaut photographs of the Earth. Other features include image highlights from shuttle missions and from the Shuttle/Mir missions. Internet guests may also view Space Shuttle orbit track maps and calculate shuttle positions when specific times are entered into the program.

Destination Earth: The Official Web Site for NASA's Earth Science Enterprise

http://www.earth.nasa.gov

This site should be your starting point for learning about NASA's Earth Science Enterprise (ESE). Includes current ESE news and events, sections on education for teachers and students, and information on current research opportunities. Many links to other information resources are also included.

Earth Observatory

http://earthobservatory.nasa.gov

Web site where the public can obtain new satellite imagery and scientific information about Earth, focusing on climate and environmental change. Visit the Earth Observatory to read feature articles on wide-ranging Earth system science topics, as well as see the latest images, media alerts, and summaries of Earth science headlines from radio, newspaper, and television. The Experiments section includes classroom activities and experiments.

Earth Observing System Data and Information System (EOSDIS) Distributed Active Archive Centers (DAAC)

EOSDIS is an integral part of NASA Earth Observing System. It is the robust distributed system that processes, archives, and manages Earth science satellite and field data, and distributes these data to a diverse global user community. Science data products (including over 700 from missions preceding EOS) are available from the DAACs, with each DAAC responsible for distributing data from specific disciplines. All data products are fully supported with documentation and technical user support.

- **Alaska SAR Facility**
  http://www.asf.alaska.edu
  Disciplines: Sea ice, polar processor imagery, synthetic aperature radar (SAR) .

- **Earth Resources Observation System (EROS) Data Center (EDC) Land Processes DAAC**
  http://edcdaac.usgs.gov/main.html
  Disciplines: Land processes .

- **Goddard Space Flight Center (GSFC) DAAC**
  http://daac.gsfc.nasa.gov
  Disciplines: Upper atmosphere, atmospheric dynamics, global biosphere, geophysics.

- **Langley Research Center (LARC) DAAC**
  http://eosweb.larc.nasa.gov
  Disciplines: Radiation budget, clouds, aerosols, tropospheric chemistry.

- **National Snow and Ice Data Center (NSIDC)**
  http://www-nsidc.colorado.edu
  Disciplines: Snow and ice, cryosphere and climate.

- **Physical Oceanography Distributed Active Archive Center (DAAC)**
  http://podaac.jpl.nasa.gov
  Disciplines: Ocean circulation and air-sea interaction.

- **Oak Ridge National Laboratory (ORNL) DAAC**
  http://www-eosdis.ornl.gov
  Disciplines: Biogeochemical dynamics.

- **Socio-Economic Data and Applications Center (SEDAC)**
  http://sedac.ciesin.org
  Disciplines: Socio-economic data related to global change.

AFFILIATED DATA CENTERS

- **National Oceanic and Atmospheric Administration Satellite Active Archive (NOAA-SAA)**
  http://www.saa.noaa.gov
  Disciplines: Satellite data-atmosphere, land, oceans, Earth science, remote sensing.

- **Global Hydrology and Climate Center**
  http://www.ghcc.msfc.nasa.gov
  Disciplines: Earth's global water cycle, the distribution and variability of atmospheric water, and the impact of human activity as it relates to global and regional climate.

EOS Project Science Office

http://eospso.gsfc.nasa.gov

The EOS Project Science Office produces a Web site which allows the user to discover, retrieve, and display EOS and Earth science resources, including documents and reports, calendar of events, images, slides, fact sheets, posters, CD-ROMs, etc.

PUMAS (Practical Uses of Math and Science)

PUMAS is the online journal of one-page examples illustrating how math and science concepts are actually used in everyday life. PUMAS examples may be activities, anecdotes, descriptions of neat ideas, formal exercises, puzzles, or demonstrations, written primarily by scientists. They are intended mainly to help K–12 teachers enrich their presentation of science and math in the classroom. Teachers can search the PUMAS collection based on curriculum topic, grade level, and subject. They can select relevant examples, and develop ideas of their own about how to integrate the material into their lesson plans. *Recommended for:* K–12 Teachers.